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Trend shocks and business cycles in Sub Saharan Africa

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Abstract

This article explores the role of trend shocks in explaining the specificities of business cycles in Sub-Saharan African (SSA) countries using the methodology introduced by Aguiar and Gopinath (2007) [Emerging Market Business Cycles: The Cycle Is the Trend Journal of Political Economy 115(1)]. We specify a small open economy model with transitory and trend shocks on productivity to replicate the differences in the business cycle behavior of output and consumption across countries, especially the excess volatility of consumption in SSA countries. Our results suggest a strong relationship between the weight of trend shocks in the source of fluctuations and economic development. The weight of trend shocks is (*i*) higher in SSA countries than in emerging and developed countries; (*ii*) negatively correlated with the level of income, the quality of institutions, and the size of the credit market; and (*iii*) uncorrelated with the aid received by countries, the ratio of trade-openness, the inflation rate, and government spending.

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1 Introduction

Sub-Saharan African (SSA) countries, which are widely known to be among the poorest in the world, are also among the most unstable economies, with the highest volatilities of output and consumption. This article explores the role of trend shocks in explaining these specificities of African business cycles.

The instability of developing economies, which has been well documented by Rand and Tarp (2002) and Ramey and Ramey (1995), generates substantial costs, directly through the welfare costs of consumption fluctuations as demonstrated by Pallage and Robe (2003) and indirectly through its consequences on growth, as discussed in Loayaza et al. (2007). A recent literature attempts to rationalize this instability within the modern business cycle framework based on dynamic and stochastic general equilibrium models.[1] Many studies on the topic have examined emerging countries[2], but few have looked at SSA countries.[3] The few studies that do exist have advanced possible explanations for the high output volatility that characterizes these economies, but none succeed in explaining the high consumption volatility, which is, in fact, higher than output volatility.

Kose and Riezman (2001) propose a model where trade shocks account for a large portion of output fluctuations, but when these shocks are combined with transitory productivity shocks, the model predicts a consumption that is as volatile as output. Arellano et al. (2000) emphasize the role of shocks to the aid received by countries in explaining the fluctuations of one African country: Côte d'Ivoire.[4] However, this economy is not representative of African business cycles because consumption is as volatile as output in Côte d'Ivoire. In Özbilgin (2010), transitory productivity shocks are amplified in low-income countries by the limited participation of agents in financial markets. This financial friction increases the relative volatility of consumption as compared to output, but it remains

[1] In their precursory contributions, Mendoza (1995) and Kydland and Zarazaga (1997) apply modern business cycle methodology to emerging countries. This approach has also been pursued by Neumeyer and Perri (2005) and Aguiar and Gopinath (2007).

[2] Emerging countries are mainly in Latin America or Asia but also in North Africa. Among the SSA countries, only South Africa is generally considered an emerging country. Emerging countries experience both accelerating growth and crisis events.

[3] Mendoza (1995) and Kose (2002) consider the average behavior of a group of developing countries that encompasses middle- and low-income countries including several SSA countries. In this paper, we employ an alternative approach that differentiates SSA countries from other developing countries.

[4] Echavarria (2008) provides an original explanation based on the importance of the informal economy in the least developed countries. However, she does not provide a quantitative assessment of this mechanism for SSA countries.

below unity. Ultimately, the existing literature does not provide a convincing explanation of why consumption has higher volatility than output in SSA countries. However, the excess volatility of consumption is a key stylized fact in the discussion of the relationship between economic development and volatility, and it explains the high welfare costs of fluctuations computed by Pallage and Rob (2003) for these countries.[5] For emerging countries, Aguiar and Gopinath (2007) explain the excess volatility of consumption by substantial volatility in the trend growth of labor productivity in these countries. In this article, we assess the relevance of this explanation for SSA countries.[6]

Aguiar and Gopinath (2007) consider a real business cycle model for small open economies in the spirit of Mendoza (1991), who examines the impact of two technological shocks on good production technology. The first is a purely transitory shock on the level of total factor productivity, whereas the second is a trend shock on the growth rate of labor productivity at the origin of the stochastic trend in the economy. Aguiar and Gopinath (2007) estimate the structural parameters necessary to reproduce the key moments of business cycle for two countries, Mexico and Canada, which exemplify emerging and developed countries. They subsequently explain the specificities of the emerging market business cycle by a higher relative weight of the trend shock (or the stochastic trend) when compared with the transitory shock (hence, they conclude that "the cycle is the trend").

We extend the work of Aguiar and Gopinath (2007) to include SSA countries. Aguiar and Gopinath (2007) succeed in collecting quarterly data for 26 countries (13 emerging and 13 developed). Unfortunately, quarterly data are not available for a large sample of SSA economies over a long sample period.[7] Therefore, we use the annual data for a relatively long sample period provided by the World Bank macroeconomic databases. We collect output and consumption series for 23 developed countries, 29 emerging countries, and 32 SSA countries (series start in 1960 for most countries and continue until 2006 in our sample).

[5] Pallage and Rob (2003) indicate that the welfare cost of fluctuations in developing countries is at least 10 times what it is in the United-States.

[6] With the exception of Houssa et al. (2010), the applications of business cycle models to SSA countries cited here do not consider permanent shocks. Houssa et al. (2010) estimate a medium-scale business cycle model for the Ghanaian economy with permanent technological shocks, which appear to be the most important source of fluctuations. However, Houssa et al. (2010) do not study the model's predictions for consumption.

[7] Peiris and Saxegaard (2007) and Houssa et al. (2010) use quarterly data for Mozambique from 1996-2005 and for Ghana from 1983-1997, respectively.

We seek to replicate the business cycle facts for the greatest number of countries possible. We quantify the structural parameters of shocks to reproduce the volatilities and the correlation of output and consumption. Our method succeeds in reproducing these factors for two-thirds of our country sample. Interestingly, the countries in which it succeeded are developed, emerging SSA countries. We can therefore study the relationship between economic development and business cycles by comparing a large number of heterogeneous countries.

First, we extend Aguiar and Gopinath's (2007) conclusion regarding emerging countries to SSA countries: there is a strong relationship between economic development and the weight of trend shocks in the fluctuations of productivity measured by the size of the random walk. Aguiar and Gopinath (2007) conclude that the size of the random walk is greater for emerging countries than for developed countries. We show that this size is even higher for SSA countries.

Second, we relate our results with the literature on the sources of fluctuations in developing countries.[8] To this end, we compare the cross-country variations in the size of the random walk with the cross-country variations in the usual determinants of fluctuations in developing countries. We find that the size of random walk is significantly decreasing with the level of income, the quality of institutions, and the size of the credit market. Interestingly, some variables that are significantly correlated with the volatility of output are not correlated with the size of the random walk. This is the case for the inflation rate, the aid received by countries, and government spending.

Third, we examine the model's predictions regarding the business cycle behavior of the ratio of net exports to output. If the model performs well to explain the volatility of this ratio across countries, then it overestimates its correlation with output. This failure mainly concerns emerging and developed countries, for which the observed ratio is countercyclical, and is less of a problem for the SSA countries, for which the observed ratio is somewhat non-cyclical.

The remainder of the paper is structured as follows. Section 2 presents the key empirical facts, and the model is presented in Section 3. Section 4 discusses the results and Section 5 concludes the

[8] Raddatz (2007) and Ahmed and Suardi (2009) provide empirical studies that are not based on business cycle models on the sources of fluctuations in developing countries, with a focus on SSA. Raddatz (2007) considers external shocks in relation to the international economy and natural disasters, and Ahmed and Suardi (2009) examine the role of trade and financial liberalization in creating fluctuations.

paper.

2 The stylized facts

In this section, we present our database and the links between economic development and business cycles. The database includes 83 countries, which are developed (22), emerging (29), or SSA (32), and is described in detail in the Data Appendix. We exclude South Africa from the SSA countries because it is generally considered an emerging country. To distinguish emerging countries from developed countries, we use standard classification. Developed countries are members of the OECD organization.[9] We do not include the United States in our database because this large country could not be modeled as a small open economy. The data used to compute the business cycle moments are the real consumption per household[10] and the real GDP per capita, both in local currency units. To compare income across countries, we use the real GDP per capita in constant USD and refer to this variable as "income" in the remainder of the paper.

Table 1 provides the average values of the four business cycle moments and of income for each group of countries. Figure 1 depicts the relationship between each of the four business cycle moments and income (the three solid lines are the outcome of a linear regression with a slope that is significantly different from zero at the 1% and the dashed line at the 5% level).

There is a negative relationship between economic development and output volatility. The standard deviation of the output of SSA countries is twice as great as that of developed countries and is significantly negatively correlated with income. There is also a strong relationship between economic development and the business cycle behavior of consumption. The increase in the standard deviation of consumption with low development is stronger than for output. The standard deviation of consumption of SSA countries is three times as great as for developed countries and twice as great as the standard deviation of output for SSA countries. Therefore, the volatility of consumption

[9] South Korea is the only OECD country that is classified as an emerging country".

[10] The data do not allow us to make the distinction between durable and non-durable goods. Alvarez et al. (2010) discuss the implications of this distinction for emerging and developed countries but not for SSA or low-income countries.

relative to the volatility of output is decreasing with economic development. The ratio of the standard deviations of consumption to output is approximately 1.05 for developed countries, 1.22 for emerging countries, and 1.98 for SSA countries. This ratio of the standard deviations significantly negatively correlated with output at the 1% level (see Figure 1). If excessive consumption volatility is widely known to characterize developing countries, then our data suggest that this volatility is much more pronounced in SSA countries. Interestingly, our database also suggests the existence of a less widely known relationship between economic development and the correlation of consumption with output. Consumption is procyclical in all countries, but the coefficient of contemporaneous correlation varies significantly according to the level of income (at the 5% level; see Figure 1). This coefficient is equal to 0.78 for developed countries but only 0.52 for SSA countries.

These stylized facts are consistent with the empirical facts described in earlier studies including SSA countries such as Ramey and Ramey (1995), Kose an Riezman (2001), Rand and Tarp (2002), Loayaza et al. (2007), and Ozbilgin (2010), even if there may be some secondary divergences due to dataset differences. We propose to use these facts to identify the sources of fluctuations for the countries of our database.

3 Identifying the sources of fluctuations

This section first presents the model (Section 3.1) and then the strategy used to identify the sources of fluctuations (Section 3.2).

3.1 The model

This section summarizes Aguiar and Gopinath's (2007) model, which is a real business cycle model for small open economies in the spirit of Mendoza (1991). The model is purely real with two shocks on the final good production technology. The authors emphasize that various sources of disturbances and frictions may be at the origin of these shocks that have to be interpreted broadly as the efficiency wedge following the definition of Chari et al. (2007).

The equations are taken from Aguiar and Gopinath (2007) using the same notation as the authors. The final good Y_t is produced with two inputs, physical capital K_t and labor L_t, according to a Cobb-Douglas technology

$$Y_t = e^{z_t} K_t^{1-\alpha} \left(\Gamma_t L_t\right)^{\alpha}, \text{ with } 0 < \alpha < 1 \tag{1}$$

where z_t is the transitory shock on the total factor productivity and Γ_t the stochastic productivity specific to labor, given by $\Gamma_t = e^{g_t}\Gamma_{t-1}$ where g_t is the trend shock. The two shocks are driven by auto-regressive processes

$$z_t = \rho_z z_{t-1} + \epsilon_z, \text{ with } |\rho_z| < 1 \text{ and } \epsilon_z \sim iid\left(0, \sigma_z\right) \tag{2}$$

and

$$g_t = \rho_g g_{t-1} + \left(1 - \rho_g\right)\mu_g + \epsilon_g, \text{ with } \left|\rho_g\right| < 1 \text{ and } \epsilon_g \sim iid\left(0, \sigma_g\right) \tag{3}$$

$e^{z_t}\Gamma_t^{\alpha}$ corresponds to the Solow Residual, which will henceforth be called the efficiency wedge as described in Chari et al. (2007).

The representative household maximizes the present sum of discounted values of utility

$$\sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{\gamma}\left(1 - L_t\right)^{1-\gamma}}{1-\sigma}\right]^{1-\sigma}, \text{ with } 0 < \gamma < 1 \text{ and } \sigma > 0 \tag{4}$$

where C_t is consumption, $(1 - L_t)$ is the leisure time, and (σ, γ, β) are structural parameters of household preferences. The per-period budget constraint of households is

$$C_t + K_{t+1} = Y_t + \left(1 - \delta\right)K_t - \frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - e^{\mu_g}\right)^2 K_t - B_t + q_t B_{t+1} \tag{5}$$

Resources consist of domestic production and debts and are allocated to private consumption and investment in physical capital. The accumulation of physical capital is subject to capital depreciation, at the rate δ, and quadratic adjustment costs, weighted by ϕ. B_t is the level of debt due as of time t and q_{t+1} is the price of debt for the period $t+1$. The representative household maximizes (4) subject to (5).

The model is closed by an upward-sloping supply of loans (not internalized by the representative

households) that links the price of debt to the debt level (divided by the stochastic trend)

$$\frac{1}{q_t} = 1 + r^* + \psi \left[\exp\left(\frac{B_{t+1}}{\Gamma_t} - b \right) - 1 \right], \text{ with } \psi > 0 \tag{6}$$

where r^* is the world interest rate, b is the steady-state level of debt, and ψ determines the sensitivity of the debt price to the deviation of debt with respect to its steady-state level. Finally, given the resource constraint of the small open economy, net exports (also called the trade balance) are equal to the changes in indebtedness (including debt interest): $NX_t = B_t - q_t B_{t+1}$.

3.2 The identification strategy

The identification strategy is based on second-order moments generated by the model computed using the Matlab programs of Aguiar and Gopinath (2007)[11] and Uhlig (1997).

Aguiar and Gopinath (2007) suggest using the differences on business cycle moments across countries to identify the sources of fluctuations. They focus on a small number of countries (2), but consider a large set of moments (11) for each to estimate several structural parameters (5) using GMM methods. We adopt an alternative strategy to accommodate the large number of countries of our database. Our strategy involves calibrating three parameters of the model to reproduce three key moments of the business cycle for each of our 83 countries. We estimate the volatility of transitory and trend shocks (σ_z and σ_g respectively) and the persistence of trend shocks (ρ_g) to reproduce (i) the volatilities of output and consumption and (ii) the correlation between output and consumption. Other parameters are set according to the benchmark parameter values of Aguiar and Gopinath (2007, Table 3 p.86): $\beta = 1/\left(1.02^4\right)$, $\gamma = 0.36$, $b = 0.10$, $\psi = 0.001$, $\alpha = 0.68$, $\sigma = 2$, $\delta = \left(1.05^4 - 1\right)$, $\rho_z = 0.95^4$, $\mu_g = 1.006^4$, and $\phi = 4$. Our strategy replicates the "Method 3" of Aguiar and Gopinath (2007, Table 4 p. 91). The performance of the model is then assessed in terms of its ability to replicate the strong differences observed in business cycles across countries.

[11] The programs are adapted for annual data.

4 Results

This section presents our results and is organized as follows. In Section 4.1, we demonstrate the existence of large cross-country differences in the size of random walk that can explain the specificities of African business cycles: the excess volatility of consumption relative to that of output and the low correlation of consumption with output. These results contrast with the literature on African business cycles discussed in Section 4.2. Then, in Section 4.3, we study the relationship between the size of random walk and the usual determinants of macroeconomic volatility in developing countries. The robustness of these results is assessed in Section 4.4. Finally, we discuss the model's predictions for the business cycle behavior of the ratio of net exports to output in Section 4.5.

4.1 Cross-country differences in the size of the random walk

Our first interest is the number of countries for which the calibration succeeds. Table 2 average reports the average values of the business cycle moments and the estimated parameters for each group of countries. Detailed results per country are given in Tables 3, 4, and 3 for developed, emerging, and SSA countries, respectively.

The calibration succeeds for two-thirds of the sample of countries, that is, for 52 of the 83 countries in our sample. If we consider the types of countries, then the calibration succeeds for 18 developed countries (78%), 18 emerging countries (65%), and 16 African countries (50%). Even if this rate of success varies notably between country types, it is satisfactory with a minimum of 50%. Given the large size of our database, we can discuss the model's predictions for a heterogeneous set of countries in terms of development. A quick look at the average of observed moments allows us to check that this sample of countries shares the same business cycle features as the complete sample of 83 countries (see Table 2). Therefore, even if we consider a smaller set of countries, the model accounts for the cross-country differences in business cycles described in Section 2.

According to our identification strategy, cross-country differences in business cycles originate in differences in the structural parameters of the shock processes. The average values for each group

of country show sizeable differences (see Tables 3, 4, and 5). The autocorrelation of the transitory shocks is set to $\rho_z = 0.95^4$ for all countries, but the standard deviations of innovation σ_z vary strongly from 0.96% (the average for developed countries) to 2.18% (the average for SSA countries). These average values hide strong variability between countries even within a group of countries. For example, the value of σ_z is lower in Ghana (about 0.0037%) than in Luxembourg (about 2.29%). The same is true for the trend shocks. The average standard innovations of trend shocks are higher in SSA countries (approximately 6.35%) than in emerging countries (approximately 5.05%) and in developed countries (approximately 0.96%), with high variability between countries (the value for the Island of $\sigma_g = 6.48\%$ is higher than for Gabon, where $\sigma_g = 2.40\%$). Developed and SSA countries show a striking difference in terms of the autocorrelation of trend shocks. The autocorrelation of trend shocks is negative or close to zero for developed countries (with an average value of $\rho_g = -0.023$) but positive for SSA countries (with an average value of $\rho_g = 0.26$).

To summarize these strong differences in the structure of parameter of shocks, we compute the size of the random walk (RWS hereafter) to measure the contribution of trend shocks to the overall fluctuations of TFP, defined as follows by Aguiar and Gopinath (2007)

$$\text{RWS} = \frac{\sigma^2_{\Delta\tau}}{\sigma^2_{\Delta_{SR}}} = \frac{\alpha^2\sigma_g^2/\left(1-\rho_g\right)^2}{\left[2/\left(1+\rho_z\right)\right]\sigma_z^2 + \left[\alpha^2\sigma_g^2/\left(1-\rho_g^2\right)\right]}$$

where $\sigma^2_{\Delta_{SR}}$ is the variance of the Solow Residual (defined by $SR_t = z_t + \alpha \log \Gamma_t$) and $\sigma^2_{\Delta\tau}$ is the variance of the random walk component of SR_t. Aguiar and Gopinath (2007) find that the random walk is greater in Mexico (equal to 1.13) than in Canada (equal to 0.38) (see column 4 of Table 4, p. 91). We also obtain sizeable differences between groups: the average random walk is equal to 0.75 for developed countries, 1.09 for emerging countries, and 1.61 for SSA countries.

Like Aguiar and Gopinath (2007), we find a significant relationship between economic development and the weight of trend shocks. The predominance of trend shocks in SSA countries explains the excess volatility of consumption in these countries. A positive transitory shock induces a smaller response of the ratio of consumption to output than a positive trend shock. These properties are attributable to the role of permanent income in general equilibrium model of business cycle. Trend shocks have permanent effects on income in contrast to transitory shocks and therefore induce a

response of consumption that is stronger than that of output. In response to a positive trend shock, households increase their propensity to consume, whereas they increase their propensity to invest in response to a transitory shock (to take advantage of temporary improvement in the marginal productivity of capital).

4.2 Relationhip with to the literature

Our model replicates the cross-country variations in the business cycle behavior of output and consumption. The high weight of trend shocks in the source of fluctuations explains both the excess volatility of consumption and its less cyclical behavior in SSA countries. This conclusion stands in contrasts with previous results obtained in the literature with other specifications of the small open economy model, which are unable to reproduce the business cycle behavior of consumption.

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Kose (2002) considers the business cycle of a typical developing country by computing the average of business cycle moments of 28 low- and middle-income countries (including several SSA countries). Kose (2002) develops the model with transitory productivity shocks and world prices shocks and shows that the latter account for a significant fraction of business cycles. However, this model fails to reproduce the business cycle behavior of consumption, which is clearly less volatile than output and highly procyclical.[12] Kose and Riezman (2001) focus on 22 African countries and consider the contribution of transitory productivity and trade shocks. Like trend shocks, trade shocks can generate the phenomenon of excess volatility. Consumption volatility is more than twice that of output when trade shocks are the only source of fluctuations. However, when both shocks are introduced, the predicted volatility of consumption is half that of output in the data used by

[12] The predicted moments are $\sigma(c) = 2.77$, $\sigma(y) = 5.58$, and $\rho(c, y) = 0.97$, whereas the empirical counterparts are $\sigma(c) = 6.17$, $\sigma(y) = 4.10$, and $\rho(c, y) = 0.64$; see Kose (2002, Table 4 p. 313).

the authors, and the predicted correlation of consumption with output is greater than the observed correlation.[13] Arellano et al. (2009) take the Côte d'Ivoire as a representative developing country to assess the contribution of aid to business cycles. The model replicates the standard deviation of consumption (around 11% at a quarterly frequency). However, this economy is not representative of African business cycles because consumption is as volatile as output in Côte d'Ivoire contrary to most SSA countries, as shown in Section 2. Moreover, the model predicts that consumption has excessively procyclical behavior.[14]

4.3 The size of the random walk and the determinants of macroeconomic volatility

Our analysis finds that the structure of shocks is the key determinant of the specificities of SSA business cycles, especially trend shocks in comparison to transitory shocks. Trend shocks should not be interpreted only in terms of variations in technological progress in the economy. According to Aguiar and Gopinath (2007), trend shocks to the efficiency wedge can be associated with regime switches or changes in government policy including dramatic changes in fiscal, monetary, and trade policies.[15] Trend shocks can also be interpreted as long-term changes in market frictions because they impact the efficiency wedge as demonstrated by Chari et al. (2007) for financial frictions and by Lagos (2006) for labor market frictions.

To obtain more information on the sources of trend shocks, we therefore compare cross-country variations in the size of the random walk with cross-country variations of the usual determinants of macroeconomic volatility in developing countries: (i) income per capita, (ii) institutional quality, (iii) the amount of aid received, (iv) the ratio of trade openness, (v) the size of the credit market, (vi) the inflation rate, and (vii) government spending. Corresponding series are defined in the Data Appendix. For each series, we measure its correlation with the standard deviation of output and

[13] $\rho(c, y) = 0.77$ for the model against $\rho(c, y) = 0.39$ in the data; see Kose and Riezman (2001, Table 5, p. 69).

[14] The predicted correlation of coefficient is $\rho(c, y) = 0.97$ against $\rho(c, y) = 0.61$ in the data; see Arellano et al. (2009, Table 3 p. 93).

[15] In the context of the great depression, Crucini and Kahn (2003) demonstrate that the tariff shifts in a multi-sectoral model correspond to changes in the efficiency wedge in a mono-sectoral model as considered here.

with the size of the random walk. The results are reported in Figures 2 and 3, which provide the scatter plots and the line of regression if the slope is significantly different from 0 at the 1% level (with a solid line), at the 5% level (with a dashed line), or at the 10% level (with a dotted line), otherwise, we do not plot the regression line.

The income is significantly negatively correlated with both output volatility (at the 1% level) and the size of the random walk (at the 10% level). This property is consistent with our results reported in the Section 4 because the average of income is highest for developed countries and lowest for SSA countries, and emerging countries are middle-income countries. Our large sample of heterogeneous countries allows us to prove the existence of a significant relationship between the structure of shocks and economic development (measured by the income per capita).

The quality of institutions is significantly negatively correlated with output volatility (at the level of 1%) and the size of the random walk (at the level of 5%). The quality of institutions has been widely recognized as a key determinant of income and growth and also, more recently, as a key determinant of macroeconomic volatility (see the works of Acemoglu et al. (2001) on growth and Acemoglu et al. (2003) on macroeconomic instability). Our results complete this literature by linking the institutions not only to output volatility but also with the contribution of trend shocks to macroeconomic fluctuations and support the interpretation of these shocks given by Aguiar and Gopinath (2007) in terms of government failures (see the beginning of this section). To be more explicit regarding economic policy, we consider two variables that capture cross-country variations in monetary and fiscal policy: inflation and government spending.[16] These two variables are strongly correlated with output volatility. In highly volatile countries, inflation is strong, and the government sector is small. However, these variables are not linked with the size of the random walk and, therefore, do not explain the excess volatility of consumption.

For the aid received (measured as a share of GDP), we exclude the developed countries from the analysis because they do not receive aid. This variable is positively correlated with output volatility. This relationship may support the approach of Arellano et al. (2010), who explain the volatility of developing countries in terms of the variability of the aid received and the objective of Peiris and

[16] Fatas and Mihov (2010) use these variables to examine the impact of policy volatility on growth. .

Saxegaard (2007) and Houssa et al. (2010) to define efficient monetary policy rules in the context of sizeable and variable aid transfers. However, this variable is not correlated with the size of the random walk.[17] Therefore, even if aid seems strongly related with economic volatility, it may not be related with the high weight of trend shocks in the SSA countries.

The openness of developing countries to trade is a key channel of transmission of international shocks to domestic countries. We measure trade openness by the sum of the export and import ratios (both in percent of GDP). Due to the trade liberalization of recent decades, this ratio is growing in most countries. The mean growth rate of trade-openness is 2.45% for our 52 countries[18] and varies between developed countries (1.51%), emerging countries (2.55%), and SSA countries (3.47%). When we compare this growth rate with the volatility of output, the relationship is positive and significant (at the 1% level). This result is consistent with Ahmed and Suardi's (2009) finding that trade liberalization is associated with greater output and consumption volatilities. However, we do not find a significant relationship between trade openness and the structure of shocks.

The last variable that we study is the size of the financial sector, which is measured by domestic credit as a share of GDP. The development of the financial sector is widely known as a key factor in economic stabilization because it allows economies to share risk and to smooth consumption, see Kose et al. (2003) among others. We find a strong and significant relationship between our measure of the development of the financial sector and both the output volatility (at the 1% level) and the size of the random walk (at the 5% level). An insufficiently developed financial sector is associated not only with macroeconomic instability but also with a high weight of trend shocks in the source of fluctuations.

4.4 Robustness

To test the robustness of our results, we re-estimate these relationships (i) without the countries with the largest random walk and (ii) for the period after 1980.

[17] We also regress the size of the random walk on the standard deviation of aid received, instead the mean of aid, and do not find a significant coefficient.

[18] The mean growth rate of trade-openness is 2.43% for our 83 countries.

Two countries have random walk size that is very large when compared with the other countries: Egypt (3.28) and Gabon (5.90). We check that our results are not determined by these two extreme points. Figure 4 plots the new estimated relationships. The suppression of these points reinforces the correlation between the size of the random walk and both income and domestic credit (the slope is now significantly different from 0 at the 1% level for both variables in contrast to the previous significance of 10% for the first and 5% for the second; see Figure 4). The suppression of these points also makes the relationship between the aid received and the size of the random walk significant at the 10% level, whereas it was not significantly different from 0 previously; see Figure 4.

Our second test of robustness considers only the period after 1980. The liberalization of trade and finance became very important in developing countries after 1980, and it is during this period that some developing countries became emerging countries and, thus, substantially different from SSA countries. We reapply the identification strategy using data from after 1980. Results reported in Table 6 are very close to those reported in Table 2 even if the estimation procedure does not converge for exactly the same countries.[19] As before, there are notable differences in the size of the random walk between developed, emerging, and SSA countries. In terms of the relationship with other variables, the size of random walk is still significantly correlated with the income, institutions, and credit variables (at the 5% level for income and institutions and at the 1% level for credit; see Figure 5). The relationship with government spending becomes significant at the 10% level. However, it is not robust and disappears if we suppress the country with the largest random walk (namely, India).

To conclude this section, if we accept that trend shocks explain African business cycle specificities (especially the excess volatility of consumption and its weak correlation with output), the importance of these shocks may be attributable to low income, low institutional quality and an insufficiently developed financial sector. In addition, trend shocks do not appear to be robustly related with aid received, inflation, trade openness, and the size of the government spending. These conclusions are robust to the treatment of the extreme case and to a shift in the sample period.

[19] The difference is notable for SSA countries. It converges for 12 countries when the data after 1980 are used in contrast to 17 when the entire sample is used.

4.5 The cyclical behavior of net exports

To complete this discussion of our results, we confront the model's predictions with the empirical moments for the ratio of net exports to output, that is, its standard deviation and its correlation with output; see Table 7. This point is important because moments for net exports are used by Aguiar and Gopinath (2007) to estimate the model. The results are mixed.

For the volatility of the ratio of net exports, the results are satisfactory. For each group of countries, the predicted average value is very close to its empirical counterpart even if this moment is not used in the calibration procedure. For the correlation of the ratio of net exports with output, the results are less satisfactory. The model predicts a procyclical ratio of net exports for all countries, but this ratio is countercyclical, especially for emerging and developed countries. This result is especially disappointing for emerging countries because the model of Aguiar and Gopinath (2007) was originally developed to account simultaneously for the excess volatility of consumption and the countercyclical ratio of net exports in emerging countries. Nevertheless, we think that this failure does not substantially detract from our conclusion (that trend shocks explain international differences in business cycles) or our methodological choice (to base our identification strategy on consumption and output data) for two reasons.

First, because we want to study a large set of SSA countries we are constrained to use annual data over several decades. Over this period, the stylized facts associated with business cycle moments on consumption are more stable and robust than those associated with moments on net exports. Aguiar and Gopinath (2007) point out that when they consider annual data for a longer time period, the excess volatility of consumption is a constant specificity of emerging countries in contrast to the strongly countercyclical behavior of the trade balance. Therefore, Aguiar and Gopinath (2007) focus only on the recent period (post-1980), during which emerging countries experienced high growth, crises, and the liberalization of trade and finance. Since we consider a longer time period, we favor more robust stylized facts to identify the sources of fluctuations, which are based on the business cycle behavior of consumption.

Second, results on net exports are essentially unsatisfactory for developed and emerging coun-

tries. Neumeyer and Perri (2005) and Aguiar and Gopinath (2007), among others, emphasize that emerging markets are characterized by high macroeconomic volatility and dramatic current-account reversals. If the first characteristic is shared with SSA countries, which are even more volatile, it is less obvious for the second characteristic. Net exports are, on average, acyclical for SSA countries and not strongly countercyclical, as in emerging countries. For our dataset, the correlation is close to zero for SSA countries, $\rho(nx, y) = -0.04$, and clearly negative for emerging countries, $\rho(nx, y) = -0.28$. This gap is consistent with the values generally reported in the literature. Mendoza (1995, Table 1, p.107) reports an average of $\rho(nx, y) = -0.080$ for African countries, -0.285 for Latin American developing countries, and -0.224 for Asian developing countries. Previous studies do not reproduce the low correlation of the ratio of net exports with output in SSA countries. Kose and Riezman (2001, Table 5, p.69) report an average value of $\rho(nx, y) = -0.10$ for a sample of SSA countries, whereas their model predicts a strongly countercyclical ratio of net exports, at $\rho(nx, y) = -0.72$. Similarly, Ozbilgin (2010) finds an average value of $\rho(nx, y) = 0.01$ for low-income countries, as compared to -0.25 for lower middle-income countries and for upper middle-income countries. His model reproduces the value for lower middle-income countries; see Ozbilgin (2010, Table 1, p.126). In this context, our results for SSA countries are not disappointing. The average value observed for SSA countries ($\rho(nx, y) = -0.04$) is not too far from the slightly procyclical behavior predicted by the model (with $\rho(nx, y) = 0.16$)

5 Conclusion

Economic growth is key for the development of the least poor countries around the world, which are mainly localized in the SSA region. A substantial literature has emphasized the crucial consequences of the average of long-run growth rate for economic prosperity; e.g., Barro and Sala-i-Martin (2003). Our results suggests that the volatility of this long-run growth rate is also important because it seems to be at the origin of the excess volatility of consumption and, therefore, the origin of the high welfare costs of fluctuations identified by Pallage and Rob (2003) and Loayza et al. (2007).

This conclusion is based on the extension of the work of Aguiar and Gopinath (2007) on

emerging countries to SSA countries. Recent contributions challenge the role of trend shocks for emerging countries. Boz et al. (2010) try to improve the model of Aguiar and Gopinath (2007) by adding a learning process to the source of productivity shocks (transitory or permanent). Garcia-Cicco et al. (2009) use long-term data for Argentina and find that the small open economy with transitory and trend shocks generates an excessively persistent ratio of the trade balance to output. Based on this failure, they propose to enrich the model with financial frictions and countrywide shocks. When the extended model is estimated, trend shocks play a negligible role in business cycles. Chang and Fernandez (2010) agree with Garcia-Cicco et al. (2009) in their comparison of the two leading explanations of emerging market business cycles using Bayesian methods of estimation and obtain results in favor of the explanation based on financial frictions rather than the explanation based on trend shocks. It will naturally be of interest for future studies to investigate the relevance of financial shocks and frictions to complete our understanding of African business cycles.

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Data Appendix

- Countries are classified as follows.
  - Developed countries are: Australia (AUS), Austria (AUT), Belgium (BEL), Denmark (DNK), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Iceland (ISL), Ireland (IRL), Italy (ITA), Luxembuorg (LUX), Netherlands (NLD), New Zealand (NZL), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzeland (CHE), United Kingdom (GRB) United States (USA)
  - Emerging countries are: Algerian (DZA), Egypt (EGY), Iran (IRN), Israel (ISR), Morocco (MAR), Tunisia TUN), Hungary (HUN), Turkey (TUR), China (CHN), India (IND), Indonesia (IDN), Korea Rep. (KOR), Malaysia (MYS), Pakistan (PAK), Philippines (PHL), Thailand (THA), Argentina (AGR), Brazil (BRA), Chilie (CHL), Colombia (COL), Costa Rica (CRI), Ecador (ECU), Mexico (MEX), Panama (PAN), Peru (PER), Uruguay (URY), Venezuala (VEN), South Africa (ZAF).
  - SSA countries are: Benin (BEN), Bostwana (BWA), Burkina Faso (BFA), Cameroon (CMR),Cape Verde (CPV), Chad (TCD), Comoros (COM), Congo Rep. (ZAR), Cote d'Ivoir (CIV), Ethiopia (ETH), Gabon (GAB), Gambia (GMB), Ghana (GHA), Guinea (GIN), Guinea-Bissau (GNB), Kenya (KEN), Lesotho (LSO), Madagascar (MDG), Malawi (MWI), Mali (MLI), Mauritania (MUS), Mauritus (MUS), Mozambique (MOZ), Namibi (NAM), Rwanda (RWA), Senegal (SEN), Seychelles (SYC), Sudan (SDN), Swaziland (SWZ), Togo (TGO), Uganda (UGA), Zambia (ZMB), Zimbabwe (ZWE)
- All macroeconomic data are from the World Bank database World Development Indicators (http://devdata.worldbank.org/dataonline/). The sample period for most of the included countries is 1960-2006, but as specified below, the date for the first observation can vary for some countries.
  - The consumption is the log of the household final consumption expenditure in local currency unit divided by the population. For the following countries, the sample begins after 1960: 1971-Germany , 1975-Botswana, 1965-Burkina Fasso, 1980-Cape Verde, 1985-Comoros, 1976-Gambia, 1985-Guinea, 1967-Mali, 1979-Mozambique, Mauritus and Namibia, 1983-Seychelles, 1979-Swaziland, 1982-Uganda, 1964-Zimbabwe, 1974-Egypt, 1964-Iran, 1994-Israel, 1966-Hungary, 1987-Turkey, 1979-Panama, and 1974-Venezuela.
  - The output is the log of the Gross National Product (GNP) per capita in local currency unit or in constant USD 2000. For the following countries, the sample begins after 1960: 1971-Germany, 1981-Cape verde, 1980-Comoros and Ethiopia, 1966-Gambia, 1979-Guinea, 1970-Guinea Bissau, 1967-Mali, 1980-Mauritus, Mozambique and Namibia, 1970-Swaziland, 1982-Uganda, 1965-Iran, and 1968-Turkey.
  - The size of the credit market is measured by the domestic credit provided by banking sector in percentage of GDP. For the following countries, the sample begins after 1960: 1970–Germany, 1962-Italy, 1976-Luxemburg, 1961-Benin, 1976-Botswana, 1985-Cape Verde, 1981-Comoros, 1962-Congo RD, 1981-Ethiopia, 1966-Gambia, 1990-Guinea, 1985-Guinea Bissau, 1966-Kenya, 1980-Lesotho, 1961-Madagascar, 1965-Malawi,1967-Mali,1971-Mauritus, 1988-Mozambique, 1990-Namibia, 1963-Rwanda, 1961-Senegal, 1971-Seychelles, 1965-Sud Africa republic, 1974-Swaziland, 1966-Uganda, 1979-Zimbabwe, 1964-Algeria, 1964-Iran, 1982-Hungary, 1968-Turkey, 1971-China, and 1969-Indonesia.

- The government spending is measured by the general government final consumption expenditure in percentage of GDP. For the following countries, the sample begins after 1960: 1971-Germany and New Zealand, 1975-Camaroon, 1986-Cap Verde, 1980-Comoros, 1981-Ethiopia, 1971-Gambia, 1981-Guinea 1970-Guinea Bissau, 1967-Mali, 1971-Mauritus, 1980-Mozambique and Namibia, 1976-Seychelles, 1965-Iran, 1961-Tunisia, 1965-Hungary, 1968-Turkey, and 1980–Panama.
- The aid received is measured by the total foreign aid received by countries in percentage of GNI. For the following countries, the sample begins after 1960: 1966-Cameroon, 1985-Cap verde, 1965-Comoros, 1980-Ethiopia, 1965-Gambia, 1985-Guinea, 1970-Guinea bissau, 1967-Lesotho, 1967-Mali, 1981-Mauritius, 1981-Mozambique, 1983-Namibia, 1968-Senegal, 1993-RSA, 1965-Iran, 1990-Hungary, 1968-Turkey, 1979-Chine, 1967-Indonesia, and 1962–Argentine.
- The ratio of net-exports to ouptut is the difference between the ratios of exportation and importation and the ratio of trade-openeness is the sum of these two ratios, respectively defined as the exports of goods and services in percentage of GDP and the imports of goods and services in percentage of GDP. For the following countries, the sample begins after 1960: 1971-Germany, 1971-New Zealand, 1965-Cameroon, 1986-Cape Verde, 1980-Comoros, 1981-Ethiopia, 1966-Gambia, 1980-Guinea, 1970-Guinea Bissau, 1967-Mali, 1977-Mauritius, 1980-Mozambique, 1980-Namibia, 1976-Seychelles, 1975-Zimbabwe, 1965-Iran, 1965-Hungary, 1980-Turkey, 1970-China, 1967-Pakistan, and 1980–Panama.
- Population is measured by the total population, the sample is 1960-2006 of all countries except Comoros 1980-2006.

- The quality of institutions is the average of the "the rule of law" provided by the "Wold Governance Indicators, 1996-2008" (http://wbi.worldbank.org) over the sample period 1996-2008 .

Tables and Figures

Category of countries (#)	$\boldsymbol{\sigma}(y)$	$\boldsymbol{\sigma}(c)$	$\boldsymbol{\sigma}(c)/\boldsymbol{\sigma}(y)$	$\boldsymbol{\rho}(c,y)$	y^*
Developed (22)	2.2605	2.3756	1.0496	0.7849	9.6744
Emerging (29)	3.9440	4.8056	1.2277	0.7370	7.4765
SSA (32)	4.5424	7.9053	1.9829	0.5209	6.1070

Notes: Observed moments are the standard deviations of output and consumption, $\sigma(y)$ and $\sigma(c)$ respectively, and the correlation between output and consumption, $\rho(c,y)$. Consumption and output series are in log and HP-filtered. The variable y^* is the average of the log of Gross Domestic Product in constant USD of 2000.

Table 1: Business cycle moments and income

Category of countries (#)	$\boldsymbol{\sigma}(y)$	$\boldsymbol{\sigma}(c)$	$\boldsymbol{\rho}(c,y)$	$\boldsymbol{\sigma}_g$	$\boldsymbol{\sigma}_z$	$\boldsymbol{\rho}_g$	**RW Size**
Developed (20)	2.3650	2.5194	0.7893	3.1864	0.9663	−0.0234	0.7567
Emerging (18)	3.7726	4.2913	0.7341	5.0550	1.6450	0.0843	1.0960
African (17)	5.4746	6.5986	0.6396	6.3509	2.1819	0.2654	1.6137

Notes: Estimated parameters are the standard deviations of innovations to transitory and trend shocks, respectively σ_z and σ_g, and the persistence parameter of trend shocks, ρ_g. Moments are defined in Table 1.

Table 2: Estimated parameters and moments

Developed Countries	$\boldsymbol{\sigma}(y)$	$\boldsymbol{\sigma}(c)$	$\boldsymbol{\rho}(c,y)$	$\boldsymbol{\sigma}_g$	$\boldsymbol{\sigma}_z$	$\boldsymbol{\rho}_g$	**RW Size**
AUS	1.9621	1.3281	0.6573	1.0270	1.3533	0.3673	0.4718
BEL	1.5105	1.6260	0.7573	1.8072	0.8461	0.1407	0.8779
CAN	2.0242	2.0399	0.8200	3.6420	0.0000	−0.4431	0.3859
DNK	1.7995	2.4540	0.6989	2.4314	0.6780	0.2752	1.5020
FIN	3.3172	3.2403	0.9238	5.2611	1.3980	−0.3203	0.4472
DEU	1.5481	1.7149	0.7992	2.9282	0.0061	−0.3854	0.4436
GRC	2.4811	2.3549	0.6888	4.3058	0.0109	−0.4961	0.3368
ISL	3.7836	5.5843	0.8685	6.4857	0.9862	0.1270	1.2244
IRL	2.7070	3.1026	0.7688	3.4649	1.4246	0.1439	0.9581
ITA	1.6624	1.9568	0.8090	3.2356	0.0092	−0.3328	0.5006
JPN	2.6417	1.8038	0.9027	2.6445	1.6867	−0.3178	0.2766
LUX	3.2730	2.0155	0.6437	1.3167	2.2909	0.4605	0.4049
NLD	1.7479	2.3294	0.7854	2.5501	0.7181	0.1791	1.2141
NZL	2.8573	2.8500	0.7785	3.3484	1.6808	0.0704	0.7207
NOR	1.6623	2.1583	0.7685	2.3322	0.7254	0.1897	1.2011
PRT	3.7674	4.8486	0.6961	4.8294	1.6524	0.2659	1.3694
ESP	2.4282	2.6556	0.9411	4.4001	0.5920	−0.3237	0.4920
SWE	2.0152	2.5060	0.7744	2.7609	0.9513	0.1664	1.0974
CHE	2.2496	1.5068	0.8671	2.1650	1.4593	−0.3049	0.2687
GBR	1.8620	2.3118	0.8371	2.7929	0.8561	0.0702	0.9413
Average	**2.3650**	**2.5194**	**0.7893**	**3.1864**	**0.9663**	**−0.0234**	**0.7567**

Notes: Estimated parameters are the standard deviations of innovations to transitory and trend shocks, respectively σ_z and σ_g, and the persistence parameter of trend shocks, ρ_g. Moments are defined in Table 1.

Table 3: Results for developed countries

Emerging Countries	$\boldsymbol{\sigma}(y)$	$\boldsymbol{\sigma}(c)$	$\boldsymbol{\rho}(c,y)$	$\boldsymbol{\sigma}_g$	$\boldsymbol{\sigma}_z$	$\boldsymbol{\rho}_g$	**RW Size**
KOR	3.1594	3.8919	0.8243	4.6238	1.4836	0.0874	0.9582
ZAF	2.0129	2.5963	0.7170	2.6456	0.8844	0.2451	1.3192
EGY	2.0933	2.7206	0.2114	1.8002	0.4902	0.5720	3.2828
ISR	2.3483	1.5610	0.8937	2.2766	1.5148	-0.3289	0.2602
MAR	3.2600	3.7175	0.7985	4.3632	1.7071	0.0914	0.8820
TUN	2.7639	4.0229	0.6375	3.7381	0.6940	0.3355	1.8730
CHN	6.4476	4.4673	0.7813	8.0501	3.0575	-0.5623	0.2268
IND	2.2956	1.7016	0.7699	1.9359	1.5447	0.0291	0.4212
MYS	3.5673	5.6792	0.8758	6.4135	0.0050	0.1568	1.3719
ARG	5.1685	6.3601	0.8991	8.6993	2.0980	-0.0717	0.7612
BRA	4.0954	4.4466	0.4735	3.4619	2.1210	0.4518	1.5470
COL	2.4228	3.0018	0.8267	3.5708	1.1262	0.0867	0.9631
CRI	3.4590	4.5737	0.7477	4.8008	1.4464	0.2193	1.2950
ECU	3.2945	2.9779	0.7708	3.4898	2.0522	0.0538	0.6113
PAN	4.9318	6.1356	0.5828	5.4483	2.1966	0.3624	1.5985
PER	5.1660	4.9941	0.8834	8.0858	2.2441	-0.3213	0.4410
URY	5.6048	6.8574	0.8856	9.1420	2.4062	-0.0422	0.7889
VEN	5.8157	7.5374	0.7967	8.4444	2.5373	0.1535	1.1260
Average	**3.7726**	**4.2913**	**0.7341**	**5.0550**	**1.6450**	**0.0843**	**1.0960**

Notes: Estimated parameters are the standard deviations of innovations to transitory and trend shocks, respectively σ_z and σ_g, and the persistence parameter of trend shocks, ρ_g. Moments are defined in Table 1.

Table 4: Results for emerging countries

SSA Countries	$\boldsymbol{\sigma}(y)$	$\boldsymbol{\sigma}(c)$	$\boldsymbol{\rho}(c,y)$	$\boldsymbol{\sigma}_g$	$\boldsymbol{\sigma}_z$	$\boldsymbol{\rho}_g$	**RW Size**
BEN	2.9344	4.2906	0.5424	3.6929	0.5231	0.3980	2.2322
CMR	5.5841	7.1782	0.7935	8.0299	2.4779	0.1542	1.1172
TCD	7.2956	7.9360	0.6688	7.7325	4.0349	0.2691	1.0840
ZAR	7.0525	9.3513	0.9186	12.4931	2.4012	-0.0360	0.8553
CIV	4.4370	6.1333	0.8578	7.2532	1.5869	0.1031	1.1051
ETH	6.0425	6.9722	0.6795	6.8813	3.1440	0.2641	1.1742
GAB	10.0948	9.1157	-0.3246	2.4008	4.9595	0.8943	5.9051
GHA	4.0624	6.3471	0.7115	6.2129	0.0037	0.2935	1.8309
LSO	5.9894	7.6975	0.4429	6.0562	2.1917	0.4577	2.1559
MDG	3.5347	3.5835	0.6420	3.3486	2.0626	0.2975	1.0125
MWI	4.6370	7.1139	0.6330	6.5531	0.0771	0.3457	2.0559
MLI	4.3603	4.4043	0.7356	4.7556	2.5715	0.1607	0.8236
MOZ	7.4476	9.4875	0.6118	8.6710	3.2080	0.3404	1.5771
RWA	8.8372	8.1760	0.6458	7.5435	5.4669	0.2949	0.8568
SEN	2.5728	3.1873	0.6649	3.0800	1.2016	0.2899	1.3635
SDN	5.1815	7.7012	0.6905	7.4692	1.1781	0.2998	1.7612
UGA	3.0048	3.4999	0.9595	5.7923	0.0208	-0.3143	0.5217
Average	**5.4746**	**6.5986**	**0.6396**	**6.3509**	**2.1819**	**0.2654**	**1.6137**

Notes: Estimated parameters are the standard deviations of innovations to transitory and trend shocks, respectively σ_z and σ_g, and the persistence parameter of trend shocks, ρ_g. Moments are defined in Table 1.

Table 5: Results for SSA countries

Category of countries (#)	$\boldsymbol{\sigma}(y)$	$\boldsymbol{\sigma}(c)$	$\boldsymbol{\rho}(c,y)$	$\boldsymbol{\sigma}_g$	$\boldsymbol{\sigma}_z$	$\boldsymbol{\rho}_g$	**RW Size**
Developed (19)	2.2186	2.2348	0.8180	2.8836	1.0930	−0.0128	0.7117
Emerging (17)	3.5584	4.1077	0.7909	5.0193	1.4426	0.0085	0.9375
African (12)	5.6441	6.4453	0.6991	6.6302	2.5657	0.2443	1.1275

Notes: Estimated parameters are the standard deviations of innovations to transitory and trend shocks, respectively σ_z and σ_g, and the persistence parameter of trend shocks, ρ_g. Moments are defined in Table 1.

Table 6: Estimated parameters and moments (for the period after 1980)

	Observed		**Predicted**	
Moments	$\boldsymbol{\sigma}(nx)$	$\boldsymbol{\rho}(nx,y)$	$\boldsymbol{\sigma}(nx)$	$\boldsymbol{\rho}(nx,y)$
Average for category of countries				
developed	1.6053	−0.1877	1.6326	0.2661
emerging	2.9768	−0.2888	3.1055	0.2190
SSA	4.6982	−0.0437	4.6282	0.1654

Notes: Observed moments are the standard deviations of net-export relative to output, $\sigma(nx)/\sigma(y)$, and the correlation between output and net-exort $\rho(nx,y)$ Net export and (log of) output series are HP-filtered).

Table 7: Moments on net exports

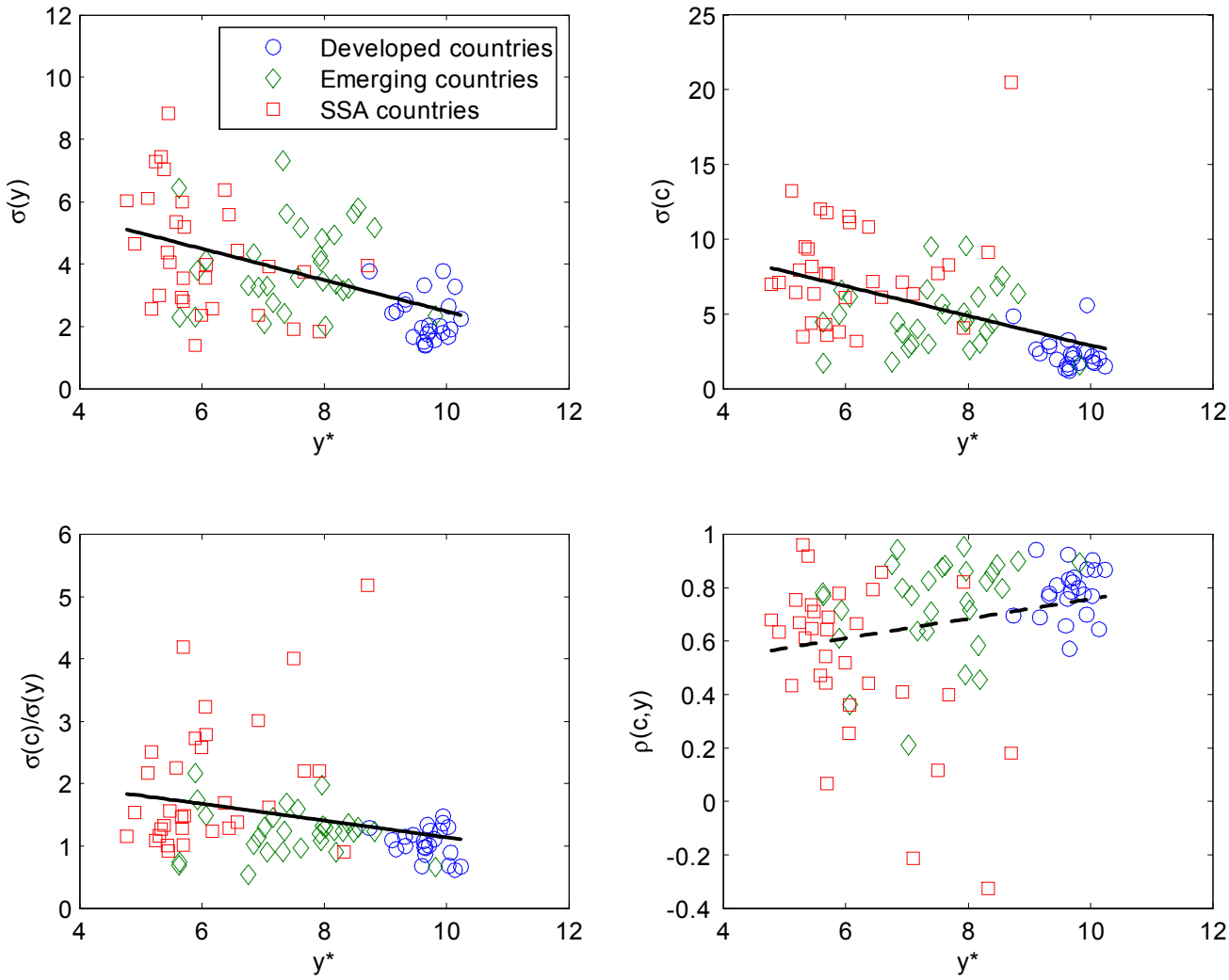

Figure 1: Development and business cycle moments

Notes: The variable y^* is the average of the log of Gross Domestic Product in constant USD of 2000. The variables c and y are the cyclical components of the consumption and the GDP (both per capita, in constant local unit currency, and in log) using the HP Filter with a coefficient of 100. The symbol σ_x denotes the standard deviation of variable $x = c, y$ in percentage and the $\rho(c, y)$ is the coefficient of correlation between c and y. " The solid, dashed, and dotted lines are the outcome of a linear regression with a coefficient significantly different from 0 at the 1

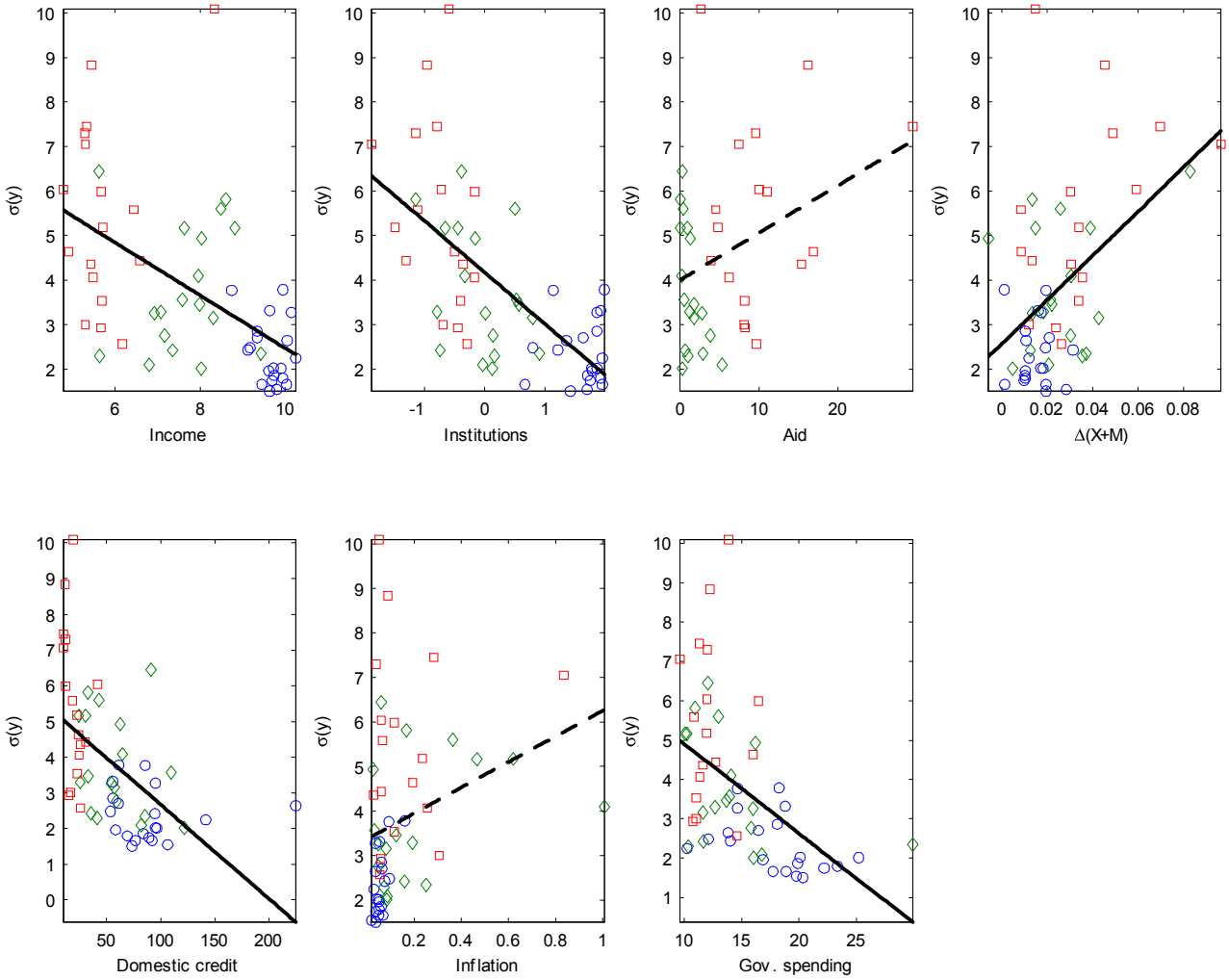

Figure 2: The output volatility and the economic environment

Notes: $\sigma(y)$ stands for the standard deviation of output. The square symbol denotes SSA countries, the diamond denotes emerging countries, and the circle symbol denotes developed countries. The solid, dashed, and dotted lines are the outcome of a linear regression with a coefficient significantly different from 0 at the 1The variables are: income, institutional quality, aid (as a share of GDP), $\Delta(X+M)$ (the average growth rate of the trade-openness ratio), domestic credit (as a share of GDP), inflation (mean growth of the consumer price index), and mean government spending (as a share of GDP). See the Data Appendix for details on the data.

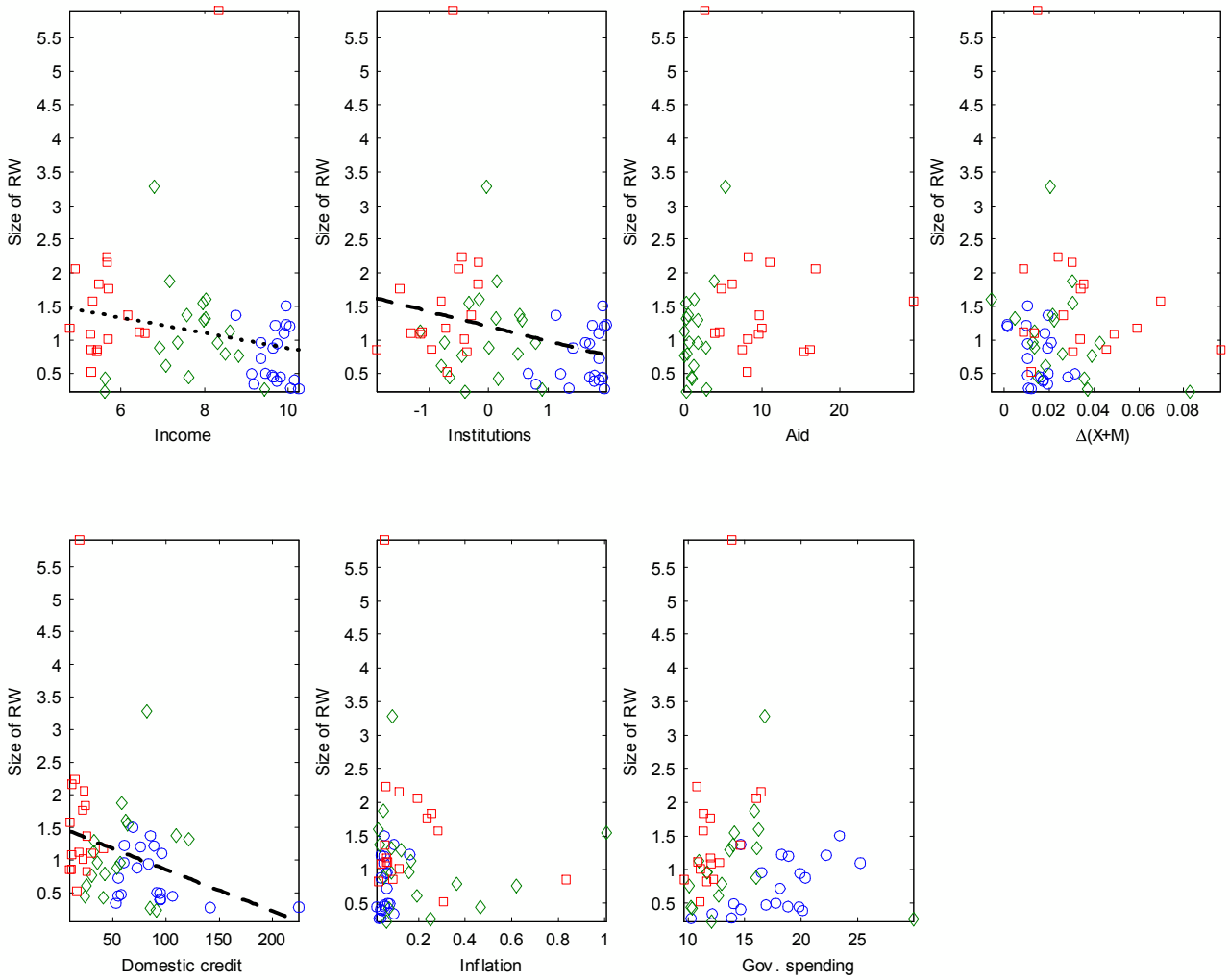

Figure 3: The size of random walk and the economic environment

Notes: RW stands for Random Walk. The square symbol denotes SSA countries, the diamond denotes emerging countries, and the circle symbol denotes developed countries. The solid, dashed, and dotted lines are the outcome of a linear regression with a coefficient significantly different from 0 at the 1The variables are: income, institutional quality, aid (as a share of GDP), $\Delta(X+M)$ (the average growth rate of the trade-openness ratio), domestic credit (as a share of GDP), inflation (mean growth of the consumer price index), and mean government spending (as a share of GDP). See the Data Appendix for details on the data.

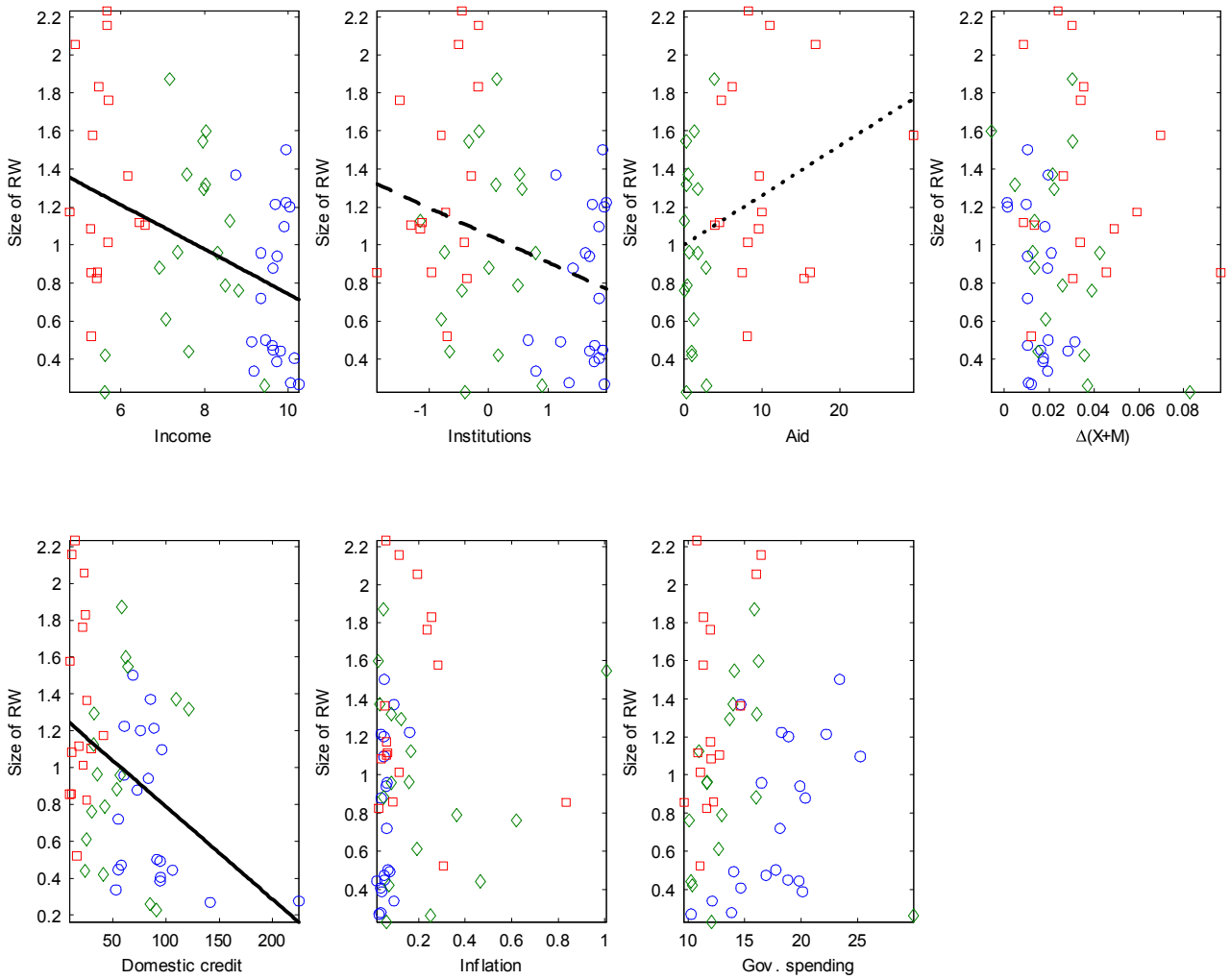

Figure 4: The size of random walk and the economic environment (without Egypt and Gabon)

Notes: RW stands for Random Walk. The square symbol denotes SSA countries, the diamond denotes emerging countries, and the circle symbol denotes developed countries. The solid, dashed, and dotted lines are the outcome of a linear regression with a coefficient significantly different from 0 at the 1The variables are: income, institutional quality, aid (as a share of GDP), $\Delta(X+M)$ (the average growth rate of the trade-openness ratio), domestic credit (as a share of GDP), inflation (mean growth of the consumer price index), and mean government spending (as a share of GDP). See the Data Appendix for details on the data.

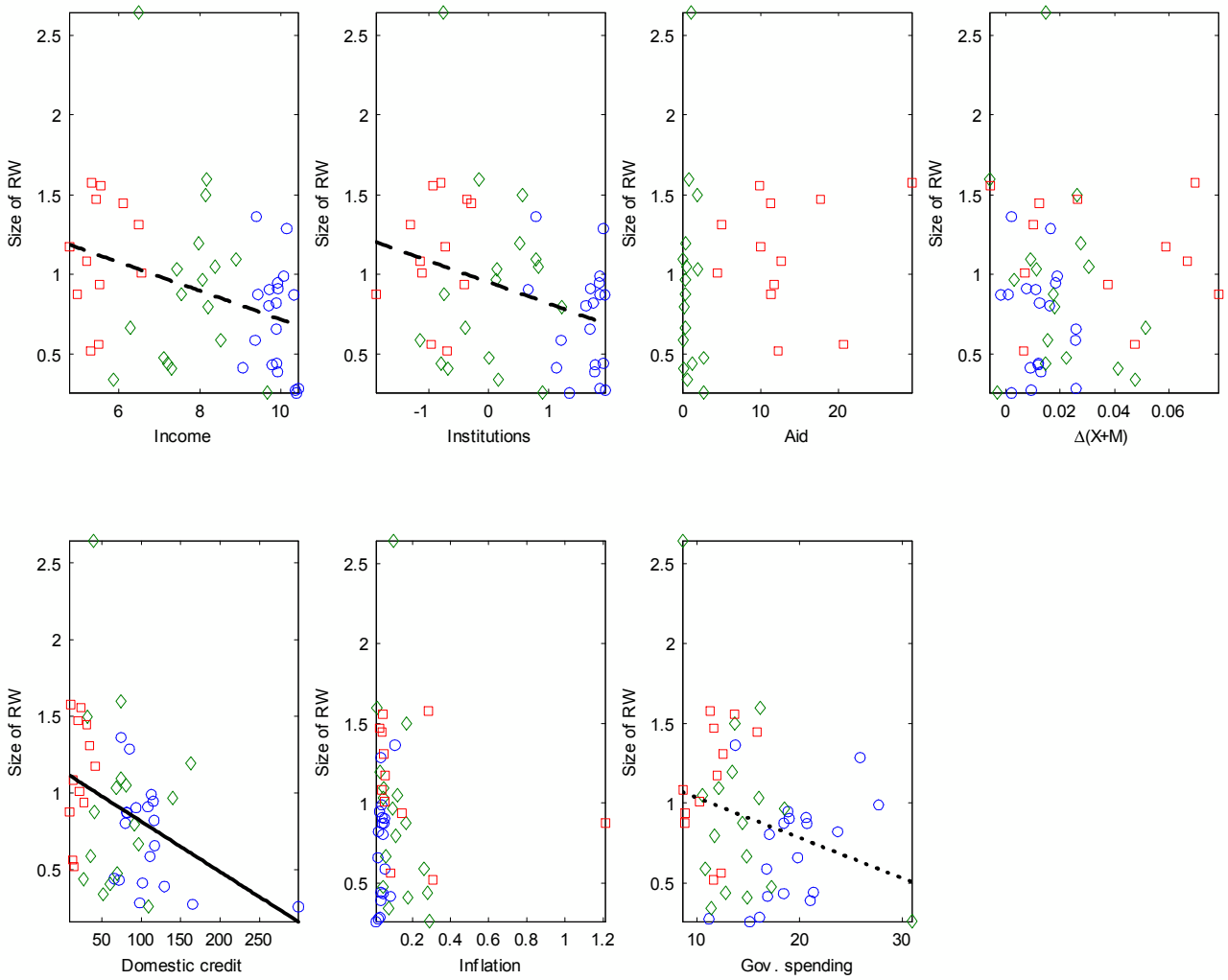

Figure 5: The size of random walk and the economic environment (after 1980)

Notes: RW stands for Random Walk. The square symbol denotes SSA countries, the diamond denotes emerging countries, and the circle symbol denotes developed countries. The solid, dashed, and dotted lines are the outcome of a linear regression with a coefficient significantly different from 0 at the 1The variables are: income, institutional quality, aid (as a share of GDP), $\Delta(X+M)$ (the average growth rate of the trade-openness ratio), domestic credit (as a share of GDP), inflation (mean growth of the consumer price index), and mean government spending (as a share of GDP). See the Data Appendix for details on the data.